Title: Counting on Converting Metric Measurements

Brief Overview:

This unit focuses on student understanding of the metric measurement system. This includes the knowledge of why different units of metric measurement are necessary and how to convert between them.

NCTM Content Standard/National Science Education Standard:

NCTM Content Standards (Grades 3-5):

- Apply appropriate techniques, tools, and formulas to determine measurements
- Carry out simple unit conversions, such as from centimeters to meters, within a system of measurement

Grade/Level:

Grade 4

Duration/Length:

4 lessons; approximately 45 minutes to 1 hour in length per lesson

Student Outcomes:

Students will:

- Show that different units of measurement are needed to measure different lengths of objects.
- Understand that the different prefixes used in the metric system denote fractional parts and multiples of a meter.
- Measure lengths to the nearest metric unit of measurement.
- Convert measurements of length on the metric scale.

Materials and Resources:

Lesson 1:

- 3 cotton balls, marked with three colors of marker
- "Magic Meter Stick" (Teacher Resource 1)
- Masking tape
- Dime
- String cut to the following lengths in the following amounts per student or per cooperative group of students: (1 meter, 10 decimeters, 10 centimeters) each length of string should be a different color.

- "Millimeter Sticks", 1 per student or cooperative group of students (Teacher Resource 2)
- "Recording Measurements Chart", 1 per student (Student Resource 1)
- 1 transparency of "Recording Measurements Chart" (Student Resource 1)

Lesson 2:

- "Cool Pool", 1 per student (Student Resource 2)
- "Magic Meter Stick" (Teacher Resource 1)
- Masking tape
- String cut to the following lengths in the following amounts: (5 decameters, 1 hectometer) each string should be of a different color.
- Trundle wheel
- "Which Unit Works Best?" (Student Resource 3)
- "Which Unit Works Best?" Answer Key (Teacher Resource 3)
- "Writing about Math", 1 per student (Student Resource 4)

Lesson 3:

- Index cards, 7 per student
- Measuring tapes, cut to exactly 1 meter, 1 per student or group of students
- "Meter Mania", 1 per student (Student Resource 5)
- "Meter Mania", 1 transparency (Student Resource 5)
- Whiteboards, 1 per student
- Whiteboard marker, 1 per students
- "How Many?" (Student Resource 6)
- "How Many? Answer Key (Teacher Resource 4)
- "Selected Response Questions", 1 per student (Student Resource 7)
- "Selected Response Questions" Answer Key (Teacher Resource 5)
- "Making More", 1 per student (Student Resource 8)
- "Making More" Answer Key (Teacher Resource 6)

Lesson 4:

- "Meter Mania" charts from Lesson 3, 1 completed chart per student (Student Resource 5)
- Calculator, 1 per student
- "Calculator Fun", 1 per student (Student Resource 9)
- "Calculator Fun", 1 transparency (Student Resource 9)
- "Calculator Fun", Answer Key (Teacher Resource 7)
- "Big/Small-Small/Big," 1 chart (Teacher Resource 8)
- "Making Conversions," 1 per student (Student Resource 10)
- "Making Conversions," 1 transparency (Student Resource 10)
- "Making Conversions," Answer Key (Teacher Resource 9)
- Measuring tapes, cut to exactly 1 meter, 1 per student or group of students

Development/Procedures:

Lesson 1

Launch

Announce to students that they will be witnessing a cotton ball-throwing contest. Choose three students to be the competitors. Give each competitor one of the colored cotton balls. Instruct each competitor to throw the cotton ball as far as they can, beginning at a pre-determined starting line. After each cotton ball lands, place a straight piece of masking tape from the starting point to where it landed. Tell the class that now they must measure the distances to see who won. Show them the "Magic Meter Stick" (Teacher Resource 1 – Assemble by cutting out each strip and gluing them together where the strip reads "tab.") and tell them that this is the tool that they will be using. Choose volunteers to help measure. They should see that a meter stick is too large of a unit to use to measure where the balls fell. Present the following question to students. "How can we fix this so that we can measure these distances in order to determine a winner?" Instruct students to ponder this situation with a partner. Choose a few students to share their answers with the class. (Possible answer cues: cut the meter stick, use a different ruler, measure in inches)

Teacher Facilitation

If students do not come up with this idea on their own, praise their prior thinking and tell them that if they only have a meter stick, they need to measure using smaller units. Present examples or benchmarks of the following units: a decimeter (width of hand), centimeter (width of pinkie), and millimeter (width of dime.) Ask students to brainstorm several other examples of items that are about the size of a decimeter, centimeter, and millimeter. (As students give answers, monitor and correct if necessary.) Share the pre-cut lengths of string that correspond to the previous units of measurement by lining them up with the appropriate units of measurement on a ruler. Model measuring one of the marked cotton ball distances using the string lengths and "millimeter sticks." (Teacher Resource 2) Start measuring from the starting line using the meter-length string. Mark where the meter-length string ends and start measuring again from the point with the meter-length string. This string will go far beyond the cotton ball. Instruct students, "In this case, we need to use a smaller unit." Ask students what the next smallest metric unit is (Answer: decimeter). Use the decimeter-length string over and over as appropriate until it too goes beyond the cotton ball. Ask the students what the next unit they should use (Answer: centimeter). Use the centimeter-length string, and then the "millimeter sticks" in the same manner until the measurement is complete. Cut the extra millimeters off of the "millimeter sticks" as needed. Fill in the information on the transparency of "Recording Measurements Chart" (Student Resource 1.)

Measure the second cotton ball distance in the same manner using student volunteers and input from class. Monitor and correct as appropriate. Repeat with the third cotton ball distance.

Student Application

Distribute student copies of "Recording Measurements Chart" (Student Resource 1) and sets of the colored string. Instruct students to measure pre-determined items in the classroom. (Note: Some thought should be put into this before the lesson. Choose items of varied lengths, at least one item measuring greater than 1 meter.) Students should record their answers.

Embedded Assessment

Throughout the lesson, perform ongoing informal assessment, including observation to determine student understanding of how long a meter, decimeter, centimeter, and millimeter actually are and in what situations each is appropriate.

Reteaching/Extension

- For those who have not completely understood the lesson, instruct in a small-group setting. As a group, measure items of varying lengths, gradually reducing the amount of teacher guidance.
- For those who have understood the lesson, they may use an actual meter stick or metric ruler to measure lengths of items. They may also measure the length of the hallway if deemed appropriate.

Lesson 2

Launch

Distribute copies of "Cool Pool" (Student Resource 2.) Ask students how they will solve the problem. (Possible answers: measure the perimeter using meters, decimeters, centimeters, or using miles or other customary unit of measurement)

Teacher Facilitation

Take students outside to a large open area where the "pool" could be located. (Prior to the lesson, mark the corners of the "pool" with masking tape. The "pool" needs to be large enough to require a unit of measurement larger than a meter.) Re-introduce "Magic Meter Stick" (Teacher Resource 1.) Choose volunteers to begin measuring the length surrounding the "pool". After using the "Magic Meter Stick" repeatedly (12-15 times), point out how tedious the task is. Ask for ideas of how to make the process simpler. Explain that just as there are units to measure items shorter than a meter, there are also units to measure items longer than 10

meters. Present the different lengths of string representing the decameter and hectometer. Have pairs of students hold 1 example of each length of string tight between the two of them on opposite ends for the whole class to see. Present examples of items whose lengths measure a decameter (lengths of a small room) and a hectometer (lengths of a football field.) Ask students to identify other items of a similar length. Ask students which length they would start with when measuring the perimeter of a pool. (Answer: hectometer.) Using student input, model how to measure the pool using appropriate units in a similar fashion as Lesson 1. Use units introduced in Lesson 1 as necessary. Explain that in some cases, even a hectometer is too small of a unit to measure length. In those cases, a kilometer is the appropriate measurement unit. Explain that it would be too difficult to measure out a kilometer of string. Even if you use an entire spool of string, it will probably not be long enough to equal a kilometer. Introduce a trundle wheel and explain its purpose (a tool that uses wheel revolutions to measure distances.) As a class, walk the distance of a kilometer using a trundle wheel. When you have walked the full kilometer, announce to students that the distance they walked from the starting point is a kilometer. Ask students to give examples of lengths that would be measured in kilometers. (Answer: roads, long distances)

Student Application

Distribute "Which Unit Works Best?" (Student Resource 3.) (Answers found on Teacher Resource 3.) Monitor student progress and correct as necessary.

Embedded Assessment

Throughout the lesson, perform ongoing informal assessment, including observation to determine student understanding of how long a meter, decameter, hectometer, and kilometer actually are and in what situations each is appropriate. As a final activity for the day, students will answer the writing prompt (Student Resource 4.)

Reteaching/Extension

- For those who have not completely understood the lesson, instruct in a small-group setting. As a group, measure the perimeter of the classroom using the units introduced in the lesson, gradually reducing teacher assistance.
- For those who have understood the lesson, they may use a trundle wheel to measure long distances in the classroom.

Lesson 3

Launch

Distribute 7 index cards to each student. Instruct them to write one of the following units of measurement on each of the fronts of the cards: kilometer, hectometer, decameter, meter, decimeter, centimeter, and millimeter. Instruct them to draw a picture that corresponds to the approximate length of the unit on the front. (Example: hectometer= football field.) After sufficient time is given for them to finish, assess the students' understanding of appropriate units of measurement by using the "every student response" method. Call out an item and have every student hold up the card that would be the best choice to measure that item's length.

Teacher Facilitation

Explain to children that they have just discussed the relationship between items and different units of measurement and now they are going to explore the relationship between the units and one meter. Write the following prefixes on the board: deci, centi, milli. Ask students to discuss possible meanings with partners. If no one is able to identify the meanings, lead students by giving examples of words they are familiar with that contain them such as centipede, millipede, and decade. Students should come to the conclusion that deci is related to 10, centi is related to 100, and milli is related to 1000. Distribute meter tape measures to students. Remind students that this is the length of a meter. Ask the following question: "If centi is related to 100. How many centimeters do you think are in one meter?" Students should guess 100. As a class count the centimeters on the meter. Distribute "Meter Mania" (Student Resource 5.) Ask students which column can be filled in. (Answer: 100 centimeters in a meter) As a class, complete the same part for deci and milli. Ask students how many hectometers are in a meter. Students should realize that the question is being asked incorrectly. If not, remind them of yesterday's pool building activity and that a hectometer is bigger than a meter. So the question should be changed to how many meters are in a hectometer. Explain to students that hecto also means 100. Students can now fill in that part of the chart. Tell students that deca, just like deci, is related to 10. Have students guess what kilo means. Lead them to the idea that it is related to 1000. Have students complete these two areas on the chart. Ask students the following question: "One decimeter is what fraction of a meter?" Students can use their tape measures to obtain this answer. Students can complete this area on their chart. Have students work in partners to complete the centi and milli parts of their charts in a similar way. After this is completed, ask the students the following question: "One kilometer is what fraction of a meter?" If students do not realize right away, explain to them that we don't make a fraction in this case, because a kilometer **is not a part** of a meter. The same goes for the other units of metric length, larger than a meter. Students should fill in column two for the units greater than a meter by writing the number of meters in each of the greater units. Review with students what the decimal for 1/10 (.1), 1/100 (.01), and 1/1000 (.001) would be. Have them record the answers in the correct place on the chart. Distribute individual white boards and markers to students. Ask students to write answers to the following questions by writing a

fraction of a meter and the corresponding decimal. One question should be asked per individual student to assess individual understanding. (Example questions: 3 decimeters is what fraction of a meter? Decimal? 10 centimeters is what fraction of a meter? Decimal?)

Student Application

Students will complete "How many?" (Student Resource 6.) Monitor and correct work as appropriate. Answers can be found on Teacher Resource 4.

Embedded Assessment

Throughout the lesson, perform ongoing informal assessment to determine student understanding of how long a meter, decameter, hectometer, and kilometer actually are and in what situations each is appropriate; as well as the relationship between the different metric prefixes and a meter. The final activity for the day will be to complete 5 selected response questions (Student Resource 7.) Answers can be found on Teacher Resource 5.

Reteaching/Extension

- For those who have not completely understood the lesson, instruct in a small-group setting. For students having difficulty understanding the relationship between a meter and the other metric units of measurement, use base 10 blocks to show how many centimeters are in a meter, etc. For students having difficulty with fraction concepts, use fraction bars review the part-whole connection of a fraction. For students having difficulty with decimal concepts, use a grid of 1000 square centimeters to identify the relationship between fractions and decimals.
- For those who have understood the lesson, students may explore the relationship between more than one meter and the smaller parts that make them up. Students will complete "Making More" (Student Resource 8). Answer key can be found on Teacher Resource 6.

Lesson 4

Launch

Instruct students to pull out "Meter Mania" from lesson 3 (Student Resource 5.) Distribute "Calculator Fun" (Student Resource 9) and measuring tapes. Tell students to use calculators to solve number 1. Answer key can be found on Teacher Resource 7. Ask a student to explain the pattern that takes place as you solve the problem on the overhead. (Answer: Every time a number is divided by 10, the decimal point moves one place to the left.) Ask students to look at number 2. Ask for a prediction of what students think will happen to the decimal point if you divide by 100. Students should solve the problem. Students should realize

that the decimal point moves over two places to the left when you divide by 100. Instruct students to predict what will happen to the decimal point when you divide by 1000 (Answer: Decimal point moves three places to the left). Instruct students to solve number 3. Tell students to look at number 4. Ask what is different about the problem (Answer: It is a multiplication problem.). Instruct students to solve number 4 using calculators. Ask a student to explain the pattern that takes place as you solve the problem on the overhead. (Answer: Every time a number is multiplied by 10, the answer moves one place to the right.) Ask students to look at number 5. Ask for a prediction of what students think will happen to the decimal point if you multiply by 100. Students should solve the problem. Students should realize that the decimal point moves two places to the right when you multiply by 100. Instruct students to predict what will happen to the decimal point when you multiply by 1000. (Answer: Decimal point moves three places to the right.) Instruct students to solve number 6. Tell students to complete numbers 7-10 with the calculators. Students will finish the problems without the calculator. Monitor work and correct as necessary.

Teacher Facilitation

Ask students what operation they will perform if they want to find out how many meters are in a given number of kilometers. (Answer: multiply) Then ask students: If you know the length of a distance in meters, what operation would you use to find the number of kilometers it would measure. (Answer: divide) Present "Big/Small-Small/Big" (Teacher Resource 7.) Explain that the chart will help them remember what operation they need to perform when converting units. (If necessary, explain that convert means to change.) Distribute "Making Conversions" (Student Resource 10.) Ask students how they can determine the number of millimeters that are equal to 5 cm. (Possible answers: Divide by 10, multiply by 10, move the decimal point.) Instruct students that it is important to remember that you must convert to meters **first**. This will avoid any confusion about going directly from centimeters to millimeters, etc. Ask students what to do to convert 5 cm to meters. (Answer: divide because according to the chart, a "small/big" conversion means that you need to divide.) Tell students that now that they know that they will need to divide to convert cm to meters, ask them how much they will divide by. (Answer: 100 because there are 100 centimeters in a meter.) Ask for a volunteer to tell the class how many meters equal 5 centimeters (Answer: 0.05 m). Ask students if the problem is completed (Answer: No, because they still have to convert back into millimeters). Ask a volunteer to explain how you will convert from meters into millimeters (Answer: multiply by 1000 because the chart tells you that Big/Small means that you need to multiply and you multiply by 1000 because there are 1000 millimeters in a meter.) Instruct students to complete this problem (Answer: 0.05 m=50mm.) In order to check this answer to be sure that it works, have students count to 5 centimeters on the measuring tape. Then ask students to count how many millimeters are in 5 centimeters. They will see that in fact, there are 50 mm in 5 cm.) Complete problems 2 and 3 as a class.

Student Application

Students will complete "Making Conversions" (Student Resource 11.) Monitor and correct work as appropriate.

Embedded Assessment

Throughout the lesson, perform ongoing informal assessment to determine student understanding of the operation needed to make metric conversions. Monitor and correct calculations as well as having chosen the correct operation as appropriate.

Reteaching/Extension

- For those who have not completely understood the lesson, instruct in a small-group setting. Emphasize the use of the "Big/Small-Small/Big" chart. Be sure to bring students' focus to the meter as the main unit of metric length measurement.
- For those who have understood the lesson, students will make up their own conversion problems to switch with a partner.

Summative Assessment:

Students should complete the summative assessment (Student Resource 11). Answers can be found on Teacher Resource 10.

Authors:

Melissa Katsirebas
Edmondson Heights Elementary
Baltimore County, MD

Veronica Muñoz
Piney Branch Elementary
Montgomery County, MD

Appendix A: Teacher Resources Teacher Resource 1

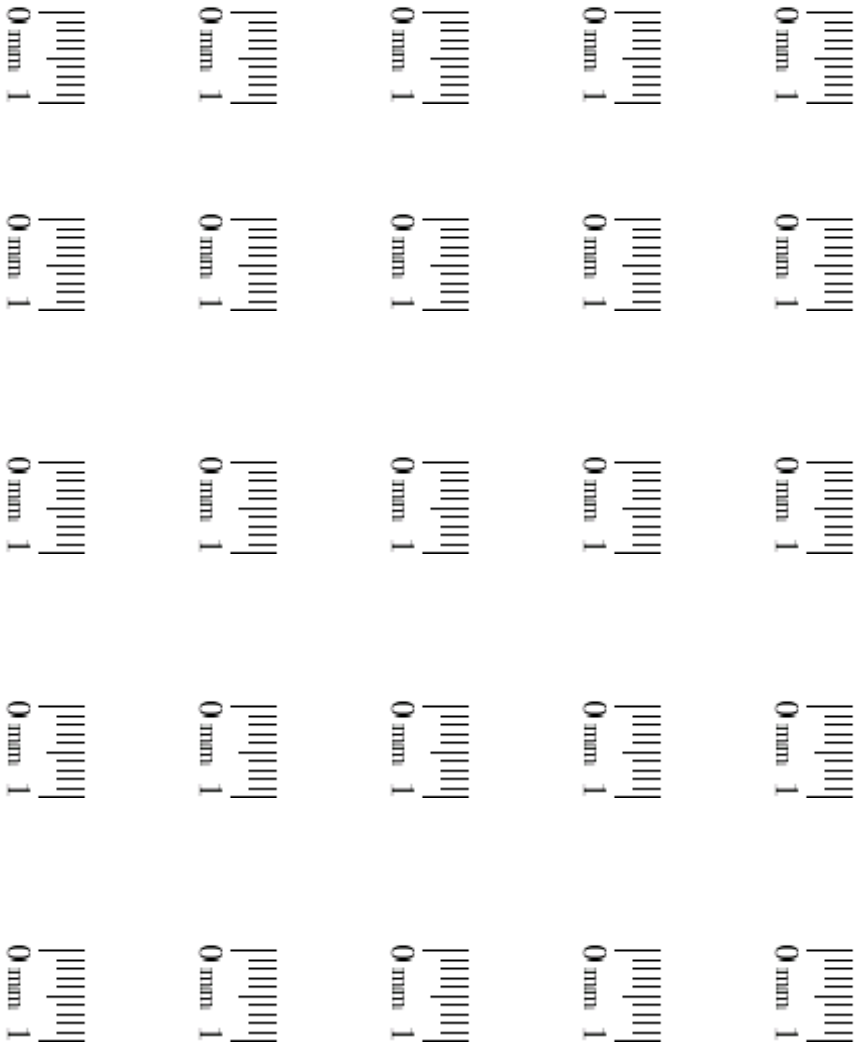
Magic Meter Stick

START	
TAB	
TAB	
TAB	
TAB	

Teacher Resource 2

Millimeter Sticks

Cut out each set of 10 millimeters. Give one set to each student to measure with. Be sure that students understand that each line represents 1 millimeter.



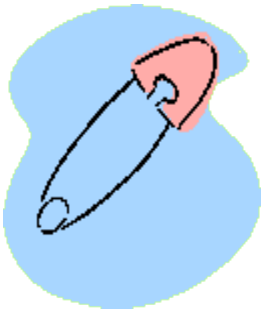
Which Unit Works Best?

Directions: Write the unit of measurement that would work the best to measure each of the items below.

millimeters

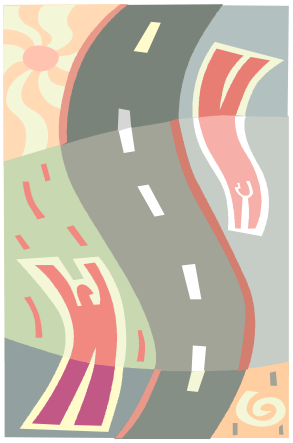
decameters

meters



centimeters

hectometers



kilometers

Name_____

Teacher Resource 4

Name:_____ Date:_____

How Many?

Complete the chart below using the information we have learned about the different parts of a meter. (Hint: Use you Meter Mania chart to help you answer these questions!)

How many?	Fraction of a meter	Decimal fraction of a meter
Ex:3 decimeters	3/10	0.3
450 millimeters	450/1000	0.450
62 centimeters	62/100	0.62
8 millimeters	8/1000	0.008
91 millimeters	91/1000	0.091
4 centimeters	4/100	0.04
7 decimeters	7/10	0.7

Teacher Resource 5

Name:_____ Date:_____

Selected Response Questions
Answer Key

Answer each of the following questions by circling the correct response. There is only one correct response for each question.

1. How many meters are in a kilometer?
    a. 100
    b. 10
    c. 1000 ☺
    d. 110

2. How many centimeters are in a meter?
    a. 100 ☺
    b. 10
    c. 1000
    d. 0

3. The length of a table measures 5 decimeters. What fraction of a meter is the length of the book?
    a. 5/100
    b. 5/10 ☺
    c. 1/5
    d. 5/1000

4. The length of a pencil measures 9 centimeters. What decimal represents the length of the pencil in meters?
    a. 0.90
    b. 0.9
    c. 0.09 ☺
    d. 0.009

5. The length of your calculator is 100 millimeters. What fraction of a meter is the length of the calculator?
    a. 100/100
    b. 100/1000 ☺
    c. 10/1000
    d. 10/1000

Name:_____ Date:_____

Making More!!! Answer Key

Using the information you have learned about the relationship between different units to answer the questions below. (HINT: refer back to Meter Mania!)

1. How many decimeters are equal to 2 meters? How do you know?

   2 meters= 20 decimeters because there are 10 decimeters in each meter

2. How many meters are equal to 3 kilometers? How do you know?

   3 kilometers= 3000 meters because there are 1000 meters in each kilometer

3. How many meters are equal to 500 centimeters? How do you know?

   500 centimeters= 5 meters because there are 100 centimeters in each meter

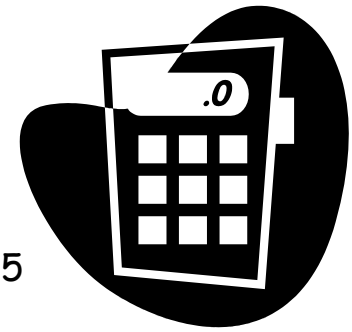
4. How many millimeters are equal to 4 meters? How do you know?

   4 meters= 4000 millimeters because there are 1000 millimeters in each meter

5. How many hectometers are equal to 200 meters? How do you know?

   200 meters= 2 hectometers because there are 100 meters in each hectometer

Calculator Fun



1. 790 ÷ 10 = 79
   79 ÷ 10 = 7.9
   7.9 ÷ 10 = 0.79
   0.79 ÷ 10 = 0.079

2. 250 ÷ 100 = 2.5
   2.5 ÷ 100 = 0.25

3. 2670 ÷ 1000 = 2.67
   2.67 ÷ 1000 = 0.00267

4. 85 x 10 = 850
   8.5 x 10 = 85
   0.85 x 10 = 8.5

5. 54 x 100 =5400
   5.4 x 100 = 540
   0.54 x 100= 54

6. 23 x 1000 = 23,000
   2.3 x 1000 = 2300.0

7. 120 ÷ 10 = 12

8. 34 x 100 = 3400

9. 1.4 ÷ 100 = 0.014

10. 3.45 x 1000 = 3450

11. 6.65 ÷ 1000 = 0.0065

12. 0.75 x 10 = 7.5